AD NUMBER
AD869839
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AUTHORITY
TECOM ltr 14 Dec 1970

(20)

25 March 1970

Materiel Test Procedure 9-2-286
General Equipment Test Activity

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

POWER GENERATORS

1. OBJECTIVE*

This document provides test methodology and testing techniques necessary to determine the technical performance and safety characteristics of power generators and associated tools and equipment as described in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), and Technical Characteristics (TC's), and to determine the item's suitability for service tests.

2. BACKGROUND

Requirements exist for power generators (ac and dc) that are portable, self-contained, and operable over a wide range of temperature, altitude and humidity. The generators considered in this document provide one-and three-phase ac and dc power and consist of a prime mover, electrical generator, alternators, control and display panel, a supporting frame or skid, and are 200 KW or less capacity.

The prime mover is a multi-fuel or gas turbine engine of sufficient rating to continuously drive the electrical generator under full load and output power without exceeding the rating specifications of the engine. The control panel is comprised of two sections: one for controlling and displaying engine performance, the second for controlling and displaying generator performance. Safety and overload monitors are also included on the control panel. The supporting frame or skid provides a rigid support for the power generator system, protects the power system from being crushed in transport, and contains adequate fastening devices to permit towing, lifting, and trailer mounting of the power generator system.

3. REQUIRED EQUIPMENT

a. Transportation Drop Test Facility.
b. Electromagnetic Interference (EMI) Testing Facility - shielded room or open area.
c. Sound Anechoic Chamber.
d. Synchronous Drive Testing Machine having a total excursion of one inch, a capacity of 1,000 pounds, and a table measuring five feet by five feet.
e. Temperature, Humidity, and Air Pressure Chamber.
f. Ohmmeter.
g. 500 vdc Megohmmeter or Bridge.
h. Dielectric Strength Tester 0-5000 VRMS, 60-500 HZ.

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*This MTP is intended to be used as a basic guide in preparing actual test plans for the subject equipment. Specific criteria and test procedures must be determined only after careful appraisal of pertinent QMR's, SDR's, TC's and any other applicable documents.

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i. Wheatstone Bridge.
j. Vibration Measuring Set.
k. Electronic Counter and Tachometer Generator.
l. EMI Instruments and Antennas per MIL-STD-461.
m. Thermometers liquid in glass °C.
n. Sound Level Meter per ASA S1.4-1961.
o. Octave band analyzer per ASA S1. 6-1960.
p. AC and DC Voltmeters (0-500v).
q. Wattmeters (one-and three-phase).
r. AC and DC Ammeters (sufficient in range to measure at least 125 percent full load current of generator).
s. Frequency Meter.
t. Power Factor Meters (one- and three-phase).
u. Waveform Analyzer.
v. Single-track Oscillograph.
w. Switches, as required.
x. Stop Watch.
y. Oil Pressure Gauge.
z. Sight Gauge Glass Assembly to indicate coolant level in a container.
aa. Manometer.
ab. Kelvin Bridge.
ac. Thermocouples and associated indicating devices.
ad. Barometer.
ae. Meter Probes.
af. Variable load with power dissipating and impedance range sufficient to vary generator load from 10 to125 percent of full load at rated power factor (normally, 0.8).
ag. Feeler Gauges.
ah. 1,000 volt, 1-uf Capacitor.
ai. Lubricants and Lubricating Equipment.

4. REFERENCES

A. AMCP 706-134, Maintenance Guide for Design.
B. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
C. USATECOM Regulation 700-1, Value Engineering.
D. USATECOM Regulation 705-4, Equipment Performance Report.
E. USAGETA (HEDGE) Human Factors Evaluation Data for General Equipment.
F. MIL-STD-129D, Marking for Shipment and Storage
G. MIL-STD-130C, Identification Marking of U. S. Military Property.
H. MIL-STD-461A, Electromagnetic Interference Requirements for Equipment.
I. MIL-STD-462, Electromagnetic Interference Characteristics, Measurement.
J. MIL-STD-463, Definitions and Systems of Units - Electromagnetic Interference Technology.
K. MIL-STD-705A, Military Standard Generator Sets, Engine-Driven,

Methods of Test and Instructions.

L. MIL-HDBK, 705A, Military Standardization Handbook Generator Sets, Electrical, Measurements and Instrumentations.
M. MIL-STD-810B, Environmental Test Methods.
N. MIL-P-116, Preservation, Methods of.
O. MIL-STD-749B, Parts and Equipment, Procedures for Packaging and Packing of.
P. HEL-STD S-1-63B, Maximum Noise Level for Army Materiel Command Equipment.
Q. ASA S1.4-1961, General Purpose Sound Level Meters.
R. ASA S1.2-1962, Physical Measurement of Sound.
S. NEMA 1C-1, Standards for Industrial Controls.
T. MTP 10-2-511, Physical Characteristics.
U. MTP 10-2-501, Operator Training and Familiarization.
V. MTP 10-2-502, Durability.
W. MTP 10-2-503, Transportability.
X. MTP 10-2-505, Human Factors Evaluation.
Y. MTP 10-2-507, Maintenance Evaluation.
Z. MTP 10-2-508, Safety.
AA. MTP 10-2-511, Quality Assurance.
AB. MTP 10-2-512, Reliability.

5. SCOPE

5.1 SUMMARY

This materiel test procedure described the following tests to be conducted on power generators.

a. Preparation for Test - A determination of the condition of the test item upon its arrival and other preparatory procedures to be completed prior to active testing. These procedures consist of the following:

1) Packaging and test item inspection
2) Inventory check
3) Physical characteristics inspection
4) Operator training and familiarization
5) Pre-operational checks

b. Operational Performance - An evaluation to examine specific operational design characteristics including the test item's ability to perform its primary function. Test item controls, indicators, and safety features will also be evaluated. The tests in this section include the following:

1) Preliminary Electrical Tests.
2) Speed and Voltage Regulation.
3) Stability and Transient Response.
4) Harmonic Analysis.
5) Ripple Voltage.
6) Vibration Test.
7) Dynamic Balance.
8) Generator Efficiency.
9) Phase Balance (Voltage).
10) Phase Balance (Current).
11) Circulating Current.

12) Rheostat Range.
13) Regulator Range.
14) Frequency Adjustment Range Test.
15) Overspeed.
16) Overspeed Protection Devices.
17) Underspeed Protection Devices.
18) Under Frequency Protection Devices.
19) Voltage Unbalance with Unbalanced Load (Line-to Neutral Load).
20) Voltage Unbalance with Unbalanced Load (Line-to-Line Load).
21) Voltage Unbalance (Three-Wire, Single Phase).
22) Voltage-Frequency Control.
23) Short-Circuit Test.
24) Circuit Interrupt Test.
25) Reverse Current Relay Test (28 VDC Generators).
26) Instrument Test.
27) Judging Commutation (AC Generators).
28) Judging Commutation (DC Generators).
29) Inclined Operation.
30) Maximum Power.
31) Parallel Operation.
32) Low Oil Pressure Protective Device Test.
33) High Water Temperature Protective Device Test.
34) High Temperature Protective Device Test (Air Cooling).
35) Low Coolant Protective Device Test.
36) Shaft Current.
37) Start and Stop Test.
38) Unbalanced Load Heating Test.
39) Heat Run.
40) Starting and Operating Test, Low Temperature, -65°F. (-54°C.).
41) Standby Operation Test, Low Temperature, -65°F.

c. Environmental Tests - An evaluation to determine the effects of adverse environmental conditions on the test item. The tests in this section include the following:

1) High Temperature Test
2) Humidity Test
3) Fungus Resistance Test
4) Sand and Dust Test
5) Salt Fog Test
6) Immersion Test
7) Altitude Operation Test
8) Storage Test, Extreme Cold, -80°F. (-62°C.).
9) Storage Test, Extreme Heat, + 160°F. (+71°C.).

d. Electromagnetic Interference - An evaluation to determine radio frequency noise generating characteristics during normal operation of power generator with all noise supression components installed.

e. Durability - An evaluation to determine ability of power generator to withstand normal operational stresses without failure.

f. Transportability - An evaluation to determine the ability of the test item to withstand the forces which it will experience during normal handling and transportation.

g. Maintenance - An evaluation to determine and appraise the test item's maintenance characteristics and requirements, a verification and appraisal of its malfunctions, an evaluation of the test item's associated publications and other common and special support elements (maintenance test package), an appraisal of the test item's design for maintainability (AMCP 706-134: accessability, ease of maintenance, standardization, and interchangeability), an evaluation of component and system durability and reliability, and the calculations of indicators which express the effects of appropriate preceding aspects.

h. Safety - An evaluation to determine the safety characteristics and possible hazards of the test item.

i. Human Factors Evaluation - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria.

j. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of reducing the cost of the test item without compromising performance and safety characteristics.

k. Quality Assurance - A study to determine the quality of the test item.

5.2 LIMITATIONS

These procedures are applicable to portable, self-contained power generators that are skid mounted and provide 200 KW or less continuous output power when fully loaded.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

6.1.1.1 Shipping and Packaging Inspections

a. Examine the preservation and packaging of the power generator and determine any non-conformance with MIL-P-116 and MIL-STD-794B. The container shall also be marked in accordance with MIL-STD-129D.

b. Record the following:

1) Evidence of damage or deterioration to packaging or shipping components and materials.
2) All identification markings.
3) All printed material accompanying the test item and agreement with test item markings.

c. Remove the test item from its shipping carrier, if applicable, and record the following:

1) Equipment, time and personnel required.
2) Comments regarding the method and materials used to secure the test item.

6.1.1.2 Test Item Inspection

The test item shall be inspected for markings in accordance with MIL-STD-130 and in addition the test item shall be visually inspected for evidence of defects, damage and wear in its manufacturing, materials, and workmanship. In particular, the following will be considered:

6.1.1.2.1 General - Inspect the test item for the following and record any discrepancies observed:

a. Metal surfaces should have been treated for rust and painted in accordance with requirements. Paint should be smooth and uniform without runs and sags.

b. Components junctions:

1) Rivets should be of a size to completely fill holes and allow for a sufficient flare over.
2) Soldering should be smooth, sound, and clean.
3) Welding should be free from slag, cracks, fractures and have a smooth, clean appearance.
4) Hardware should be sufficient size and strength and be tightly drawn.
5) Seams, joints, and edges should have a good fit and alignment and there shall be no sharp edges or burrs.

c. Ensure that all controls, indicators, access ports, and points of attachment are marked clearly and legibly as to their function.

d. Verify that all doors and covers have the proper fit and operate easily.

e. Examine the test item and ensure that controls and indicators conform to NEMA IC-1.

f. Inspect for improperly protected wiring.

g. Check all electrical cables and connectors for damage and secure mating.

h. Verify that all hardware items are standard and preferred types and sizes.

i. Ensure that the control panel has sufficient controls and indicators to control and monitor the performance of the power generator according to requirements.

6.1.1.2.2 Frame - Inspect the frame for the following and record all discrepancies observed:

a. Frame shall be rigid and durable towing skids.

b. Ample mounting and fastening holes, eyes, etc. shall be provided for lifting, towing or trailer mounting the electrical power generator.

c. When generator set as lifted at central lifting eye or similar

device, generator set shall not tilt more than 15 degrees from normal operating position.

d. Frame should not interfere with accessibility of components for examination, test, diagnosis, repair, or replacement of electrical power generator.

6.1.1.2.3 Engine - Inspect the engine for the following and record all discrepancies observed:

a. Verify that engine is attached to frame such that the engine can be readily removed for repair without removing generator or control panel.

b. Ensure that engine supports are adequate and also provide for inherent engine alignment.

c. Lubrication, oil, water, and fuel fill points should be accessible so that servicing can be performed without spillage on assembly or components.

6.1.1.2.4 Engine Accessories - Inspect the engine accessories for the following and record any discrepancies:

a. All accessories should be located so that they can be easily serviced and replaced.

b. If used, radiator should be removable without disassembling generator assembly; fan belt should be accessible for adjustment and replacement.

c. Batteries should be accessible and removable without disassembling generator assembly.

d. Engine accessories should be standard items that can be replaced without special modification of the replacement part.

e. Verify that fuel and lubrication lines are protected from damage due to vibration.

f. Fuel valves should be accessible and clearly labeled.

g. Fuel tank should be protected from damage due to accidental physical force and possible electrical shorts.

h. Ensure that shafts on carburetor, governors, etc., are mounted in a non-slip fashion and automatically line up with their control arms.

6.1.1.2.5 Generator - Inspect the generator for the following and record any discrepancies:

a. Generator mounts should be independent and accessible such that the generator can be removed and installed without removing or blocking up engine.

b. Engine-generator coupling devices should be accessible and easily removed and installed.

c. Exciter and generator brushes should be accessible for replacement.

d. Generator lubrication points should be accessible.

e. Generator-engine alignment should be inherent or dowel pins and other alignment aids should be provided.

6.1.1.2.6 Electrical Accessories - Inspect the electrical accessories for the following and record any discrepancies:

a. Generator accessories such as regulators and breakers should be accessible for repair and replacement.

b. Terminal strips should be used so that unit replacement of panel boards, etc., can be made without recabling.

c. Connections between elements on a terminal board and their leads should be such that they can be quickly opened to facilitate repair and/or replacement, but are not loosened by vibration.

d. Adjustments of regulating devices should be easily completed using simple, common tools.

e. Shafts on adjusting devices should have a flat spot so that indicators will automatically line up.

6.1.2 Inventory Check

Verify completeness of the test item, its maintenance and test package, and associated parts and material with the Basic Issue Item List (BIIL) and file an Equipment Performance Report (EPR) if items are missing or inadequate.

6.1.3 Physical Characteristics

The physical characteristics of the test item shall be determined by performing the applicable sections of MTP 10-2-500.

6.1.4 Operator Training and Familiarization

a. Orient engineering test personnel using the criteria of MTP 10-2-501.

b. Record all pertinent data.

6.1.5 Pre-Operational Checks

Perform the following:

a. Depreservation and assembly - remove all preservation from the test item and attach any devices, etc. which are removed from the test item for transporting convenience. Ensure that all connectors, cables, mechanical linkages, etc., are firmly and correctly installed.

b. Controls - check all electrical, mechanical and hydraulic controls for freedom and smoothness of operation.

c. Adjustment mechanisms - check these for smoothness of adjustments and to ensure that they are sufficiently secure to avoid any undesirable effects due to vibration.

d. Lubrication - verify complete lubrication of the test item ensuring that all oil holes, grease fittings, and sumps are designed to exclude foreign material.

e. Filters - verify that fuel and oil filters and air cleaners are clean and properly installed.

f. Suppression - ensure that capacitive and inductive radio frequency supression devices are installed taking note that firm, clean, and tight metal-to-metal contact is maintained.

g. Coolant - verify that engine coolant is installed that is rated

for the expected ambient temperature range of power generator operation.

h. Battery - verify that the battery electrolyte has been installed and that the battery is fully charged.

i. Ensure that the power generator is grounded to its support assembly and that this assembly is earth-grounded as described in the draft technical manual.

6.2 TEST CONDUCT

NOTE: 1. Prepare an Equipment Performance Report for any equipment malfunction incurred in completing the following procedures.
2. During the conduct of all tests, test personnel shall observe the proper safety precautions and in particular, shall adhere closely to the instructions for the handling and use of the test item.
3. The procedures for all tests and the test item shall be examined and any condition which might constitute a safety hazard shall be recorded and also reported to the testing officer.

6.2.1 Operational Performance

6.2.1.1 Preliminary Electrical Tests

a. Without power output leads connected to the test item and with the engine stopped, close the power generator output circuit breaker.

b. Using the ohmmeter, check that each output power lead is ungrounded in all positions of the output voltage and phase selector switches and that the earth or building ground lead is connected to the test item.

NOTE: Disconnect shunt components of voltage rating lower than the test voltages while performing procedures in steps c and d.

c. Using the megohmmeter, measure and record the insulation resistance between each winding with its associated circuit and the test item ground with all other circuits connected to the test item ground.

d. Using the dielectric strength tester, test each circuit by applying the test voltage between the circuit ground with all other circuits connected to ground. The values and durations of the voltages applied to the generator armature, field and exciter windings, starting components, etc., are as specified in the QMR, SDR, or applicable military specification.

e. Using appropriate feeler gauges, measure armature-field air gap in at least eight places 45 degrees apart including one measurement at bottom of armature. Record measurements taken.

NOTE: While performing the following procedures, if the power generator assembly becomes excessively noisy or emits smoke, immediately shut down generator assembly. Also, continuously check oil pressure gauge, temperature gauge, current and volt-

age output meters, and any other monitoring devices to ensure operation within the parameters of the power generator.

6.2.1.2 Speed and Voltage Regulation

a. Perform the procedures given in Method 614.1, MIL-STD-705A and record all results.

b. After warming engine, vary engine speed from idle to full speed in five steps. Observe that the engine runs smoothly at each speed without sputtering, backfiring, or missing.

6.2.1.3 Stability and Transient Response

Perform Method 608.1, MIL-STD-705A and record all results.

6.2.1.4 Harmonic Analysis

Perform Method 601.4, MIL-STD-705A and record all results.

6.2.1.5 Ripple Voltage

Perform Method 650.1, MIL-STD-705A and record all results.

6.2.1.6 Vibration Test

a. Perform Method 740.1a, MIL-STD-705A and record all results

NOTE: In the event of equipment failure during the vibration test, the procedures of the maintenance section will be performed and the vibration test rerun following repair of the test item.

b. Record maintenance performed, if any

6.2.1.7 Dynamic Balance

Perform the following:

a. Instrument the generator bearing housing with a vibration measuring test set.

b. Operate power generator from minimum to maximum load and speed.

c. Measure and record amplitude of vibration at generator bearing housing for each speed and load.

d. Observe and record if unusual noises or excessive vibration is present.

6.2.1.8 Generator Efficency

Perform Method 415.0, MIL-STD-705A and record all results.

6.2.1.9 Phase Balance (Voltage)

Perform Method 508.1b, MIL-STD-705A and record all results.

6.2.1.10 Phase Balance (Current)

Perform Method 508.2, MIL-STD-705A and record all results.

6.2.1.11 Circulating Current

Perform Method 509.1, MIL-STD-705A and record all results.

6.2.1.12 Rheostat Range

Perform Method 510.1b, MIL-STD-705A and record all results.

6.2.1.13 Regulator Range

Perform Method 511.1b, MIL-STD-705A and record all results.

6.2.1.14 Frequency Adjustment Range Test

Perform Method 511.2a, MIL-STD-705A and record all results.

6.2.1.15 Overspeed

Perform Method 505.1, MIL-STD-705A and record all results.

6.2.1.16 Overspeed Protection Devices

Perform Method 505.2, MIL-STD-705A and record all results.

6.2.1.17 Underspeed Protection Devices

Perform Method 506.1, MIL-STD-705A and record all results.

6.2.1.18 Under Frequency Protection Devices

Perform Method 514.1, MIL-STD-705A and record all results.

6.2.1.19 Voltage Unbalance With Unbalanced Load (Line-to-Neutral Load)

Perform Method 620.1, MIL-STD-705A and record all results.

6.2.1.20 Voltage Unbalance with Unbalanced Load (Line-to-Line Load)

Perform Method 620-2, MIL-STD-705A and record all results.

6.2.1.21 Voltage Unbalance (Three-Wire, Single-Phase)

Perform Method 620.4, MIL-STD-705A and record all results.

6.2.1.22 Voltage-Frequency Control

Perform Method 511.3a, MIL-STD-705A and record all results.

6.2.1.23 Short Circuit Tests

Perform Method 625.1b, MIL-STD-705A and record all results.

6.2.1.24 Circuit Interrupt Test

Perform Method 512.2b, MIL-STD-705A and record all results.

6.2.1.25 Reverse Current Relay Test (28 vdc Generators)

Perform Method 512,4b, MIL-STD-705A and record all results.

6.2.1.26 Instrument Test

Perform Method 513.1b, MIL-STD-705A and record all results.

6.2.1.27 Judging Commutation (AC Generators)

Perform Method 651.1b, MIL-STD-705A and record all results.

6.2.1.28 Judging Commutation (DC Generators)

Perform Method 651.26, MIL-STD-705A and record all results.

6.2.1.29 Inclined Operation

Perform Method 660.1b, MIL-STD-705A and record all results.

6.2.1.30 Maximum Power

Perform Method 640.1b, MIL-STD-705A and record all results.

6.2.1.31 Parallel Operation

Perform Method 630.1b, MIL-STD-705A and record all results.

6.2.1.32 Low Oil Pressure Protective Device Test

Perform Method 515.1, MIL-STD-705A and record all results.

6.2.1.33 High-Water Temperature Protective Device Test

Perform Method 515.2, MIL-STD-705A and record all results.

6.2.1.34 High-Temperature Protective Device Test (Air Cooling)

a. Install several thermocouples under engine head gasket and

in oil pan.

b. Operate engine at rated speed.

CAUTION: If the engine fails to shut down when engine or oil temperature exceeds maximum trip-out value specified in the technical characteristics, or applicable military specification, immediately discontinue test.

c. Block air passage through engine cooling fins. Close panel doors, and any other air intake or exhaust ports on engine housing.

d. Load generator to raise engine temperature.

e. Record thermocouple reading at point where temperature protective device operates.

6.2.1.35 Low Coolant Protective Device Test

Perform Method 515.3a, MIL-STD-705A and record all results.

6.2.1.36 Shaft Current

Perform Method 652.1, MIL-STD-705A and record all results.

6.2.1.37 Start and Stop Test

Perform Method 503.1a, MIL-STD-705A and record all results.

6.2.1.38 Unbalanced Load Heating Test

Perform Method 621.1, MIL-STD-705A and record all results.

6.2.1.39 Heat Run

Perform Method 680.1a, MIL-STD-705A and record all results.

6.2.1.40 Stating and Operating Test, Low Temperature, -65°F. (-54°C.)

Perform Method 701.1b, MIL-STD-705A and record all results.

6.2.1.41 Standby Operation Test, Low Temperature, -65°F. (-54°C)

Perform Method 702.1a, MIL-STD-705A and record all results.

6.2.2 Environmental Tests

Determine the effects of adverse environmental conditions on the test item by performing the following:

6.2.2.1 High Temperature Test

Perform Method 710.1b, MIL-STD-705A and record all results.

6.2.2.2 Humidity Test

Perform Method 711.1b, MIL-STD-705A and record all results.

6.2.2.3 Fungus Resistance Test

Perform Method 711.3, MIL-STD-705A and record all results.

6.2.2.4 Sand and Dust Test

Perform Method 711.4, MIL-STD-705A and record all results.

6.2.2.5 Salt Fog Test

Perform Method 711.5, MIL-STD-705A and record all results.

6.2.2.6 Immersion Test

Perform Method 711.6, MIL-STD-705A and record all results.

6.2.2.7 Altitude Operation Test

Perform Method 720.1b, MIL-STD-705A and record all results.

6.2.2.8 Storage Test, Extreme Cold, -80°F. (-62°C)

Perform Method 731.1a, MIL-STD-705A and record all results.

6.2.2.9 Storage Test, Extreme Heat, +160°F. (+71°C)

Perform Method 732.1a, MIL-STD-705A and record all results.

6.2.3 Electromagnetic Interference

This test shall be conducted in accordance with the requirements of MIL-STDS-461A, 462, and 463, for Class IIIB equipment, as follows:

TEST	DESCRIPTION
CE03*	150 KHz to 50 MHz, Power Leads
RE05	150 KHz to 1 GHz, Vehicles and Engine-Driven Equipment

* 10 microfarad feed through capacitor shall be removed.

a. Set up the measuring equipment and antennas required by MIL-STD-461A.

b. Calibrate the equipment where required.

c. With the test item in a normal operating configuration perform the tests specified by MIL-STD-462.

d. Conduct the subtests listed above, record frequencies and levels of interference.

e. Prepare a diagrammatic layout of the test site showing the test item and locations at which measurements were made.

f. Compare the interference readings with the allowable limit graphs of MIL-STD-461 and note out-of-tolerance readings.

6.2.4 Durability

a. Perform the procedures required by MTP 10-2-502 and Method 690.1b, MIL-STD-705A.

b. At the beginning and conclusion of the test perform the following inspection:

1) Disassemble the engine sufficiently to inspect the combustion chamber, pistons, piston rings, valves, manifolds, and all parts and passes in the engine block, bearings, crankshaft connecting rods, and cylinder head.
2) Clean and inspect the fuel system and governor.
3) Inspect ferromagnetic parts, such as connecting rods, piston pins, camshaft, springs, bolts, pistons, and crankshaft for cracks and defects.
4) Carefully examine all nonferrous parts to detect cracks, checks, blowholes, sand or any weakening effects.
5) Record all defects.
6) Reassemble the engine.

NOTE: In the event of equipment failure during the durability test, the procedures of the maintenance section will be performed and the durability test rerun following repair of the test item.

6.2.5 Transportability

Perform the applicable sections of MTP 10-2-503.

NOTE: The technical manual shall be reviewed or consulted for proper procedures for tying down and lifting, and transporting the item by various media. Any inadequacy of instructions should be reported by EPR.

6.2.6 Maintenance

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507 and MTP 10-2-512 with emphasis on the following:

a. Organizational (O), Direct Support (F), and General Support (H) Maintenance requirements.

b. Operator through General Support Maintenance Literature.

c. Repair parts.

d. Tools.
e. Test and handling equipment.
f. Calibration and maintenance facilities.
g. Personnel skill requirements.
h. Maintainability.
i. Reliability.
j. Availability.

6.2.7 Safety

Perform the procedures described in the applicable sections of MTP 10-2-508 and the following:

a. Determine the adequacy of all safety devices by performing the following:

1) Prepare a list of all safety devices used with the test item.
2) For any device not tested during the conduct of paragraph 6.2.1 simulate the type of failure which the device is to detect.
3) Record the following data for each safety device:

a) The device/feature tested
b) Failure which the device is to detect
c) Operation of the safety device

b. Examine the test item for the following and record any discrepancies:

1) Electrical parts shall be so located or enclosed so that suitable protection against accidental contact with uninsulated energized circuits is provided.
2) All internal wiring shall be protected against heat and contact with moving parts.
3) Where connections are made to internal wiring, a barrier-type terminal board or equivalent shall be used for secure lead attachment and protection against accidental contact of leads adjacent to each other.
4) Where line cords are used, they shall be of sufficient current carrying capacity; shall be protected against rubbing at access ports by insulated bushings, and shall be sufficiently strain-relieved to withstand approximately 5 pounds of pull.
5) Where line fuses are used, they shall be of a value consistent with the requirements of the test item and loads.
6) Where switches are used, they shall be of sufficient current capacity and mounted so as not to allow movement.
7) All metal parts shall be electrically bonded and grounded to prevent static electrical buildup.
8) The materials used in the engine and generator shall be inherently nonflammable and nonexplosive.
9) Where the normal operating temperature of the engine and generator shall be sufficient to cause a burn a protective plate, insulation, or a warning note stating this fact shall be attached to the dangerous area.

10) All moving parts of the set shall be enclosed to avoid accidental contact when the test item is operating.
11) All propellers or impellers shall be securely attached to the motor shafts.
12) All external surfaces and internal surfaces (those exposed during maintenance) shall have no sharp edges.
13) The blades or impellers and shafting shall be sufficiently strong and designed with adequate clearance to prevent contact with casings or prevent distortion under conditions of deposit loading or other factors.
14) Where capacitors are used, they shall be housed in a suitable enclosure which will provide protection and also prevent the emission of flame or molten material in the event of a failure.
15) Presence of overspeed protective devices.
16) Adequate protection from fuel spillage or leakage.

c. Record the absence of any safety features and suggestions for additional safety devices which will improve the safety characteristics of the test item.

6.2.8 Human Factors Evaluation

6.2.8.1 General Evaluation

Throughout the test, evaluate the effectiveness and characteristics of the man-item interaction as related to human factors by performing the applicable sections of MTP 10-2-505 and the following:

a. Prepare checklists to evaluate the human factor characteristic using Human Factors Evaluation Data for General Equipment (HEDGE) for the Class IIIC equipment, including the following:

1) Operability:

a) Assemble and set up
b) Prepare for use
c) Activate/deactivate and perform prime function

2) Maintainability:

a) Perform routine maintenance
b) Detect malfunction and isolate and identify cause
c) Remove defective component and replace or repair

3) Transportability:

a) Prepare for transport.
b) Load/unload.
c) Record any inadequacies of test item design affecting ease of operation.

d) Record any recommendations to improve man-item effectiveness.

b. Evaluation of the tasks of step a shall include but not be limited to the following:

1) Adequacy of instructions and tools to perform the task
2) Mental and physical effort required
3) Design of the test item as it affects the task
4) Time required for the task
5) Personnel required for the task
6) Degree of skid required and adequacy of MOS training provisions

6.2.8.2 Noise Evaluation

6.2.8.2.1 Preparation for Test - Determine the measuring locations for the microphone around the test item, using the following criteria:

a. The test item shall be in its normal operating position as in 6.2.11.
b. There should be no obstructions between the measuring microphone and the test item.
c. Measuring locations for the microphone shall be approximately every 20° along a circular path whose radius is approximately ten feet from the approximate geometric center of the test item.
d. The microphone shall be encased in a sound abosrbing enclosure which will be open only on the side facing the test item to minimize indirect reflections.

6.2.8.2.2 Test Conduct - Perform the following:

a. Calibrate the sound level meter and set the weighting network switch to the "flat response" or C position.
b. Determine the highest sound pressure level in each band over all the bands at each location, (Table I) with the test item operating at a normal level.
c. With the test item inoperative, determine the ambient noise level for the point of highest sound pressure in each band.

TABLE I

SERIES 2 FREQUENCY ANALYSIS

BAND	FROM	TO	CENTER FREQUENCY* (cps)	MAX STEADY STATE NOISE LEVEL (dB)
1	37.5	75	53	120
2	75	150	106	115
3	150	300	212	109
4	300	600	425	101
5	600	1200	850	93
6	1200	2400	1700	89
7	2400	4800	3400	89
8	4800	9600	6800	91

*Defined as geometric mean of cut-off frequencies.

6.2.9 Value Analysis

During the conduct of all tests, personnel shall examine the materials, construction and design of the test item from a value standpoint in an effort to effect cost reduction of the test item. USATECOM Regulation 700-1 shall serve as a basis for this evaluation. Perform the following:

a. Examine the test item in the following cost reduction areas:

1) Deletion of ineffective or unnecessary features or components.
2) Substitution of less expensive but comparable component or material.
3) Changes in the design to reduce the cost of manufacturing.

b. Examine all proposals to determine that the performance and safety characteristics have not been lowered.

c. Record the following for each suggested change:

1) Component or feature involved
2) Suggested change
3) Reasons for the suggestion

6.2.10 Quality Assurance

Determine the quality of the test item as described in the applicable section of MTP 10-2-511.

6.3 TEST DATA

NOTE: In compiling the Test Data section, test personnel should expound upon those data procedures which are other than quantitative in nature by recording narrative descriptions which will provide full details of conditions and/or events occurring during the conduct of the test.

6.3.1 Preparation for Test

6.3.1.1 Initial Inspection

6.3.1.1.1 Shipping and Packaging Inspection -

Record the following:

a. Any noncompliance with the standards for shipping, marking, preservation and packaging.

b. Evidence of damage, identification markings and list of printed matter enclosed.

c. Equipment, time, and personnel required to unpack the test item and comments concerning the method and materials used in packing.

6.3.1.1.2 Test Item Inspection -

Record the following:

a. General:

1) Any instances of noncompliance with the marking requirements of MIL-STD-130C.
2) Evidence of defects in the manufacturing, materials and workmanship.
3) Ineffective legends.
4) Doors or covers which have an improper fit.
5) Any instances of noncompliance with the NEMA standards for generator and controls.
6) Loose or unprotected power leads.
7) Damaged cables or connectors or those with an improper fit.
8) Presence of nonstandard hardware items.
9) Lack of sufficient controls and indicators to control and monitor power generator performance.

b. For the frame:

1) Rigidity of frame; presence of towing skids
2) Sufficiency of lifting, towing, and mounting provisions
3) Accessibility of power generator components.

c. For the engine:

1) Ease of engine removal and installation.
2) Sufficiency of engine mounts; degree of inherent alignment provided by engine mounts.
3) Ease of servicing engine.

d. For the engine accessories:

1) Ease of component removal and installation.
2) Accessibility of radiator and fan belt assembly.
3) Accessibility of battery.
4) Presence of nonstandard hardware items.
5) Vulnerability of fuel and lubrication lines to damage due to vibration.
6) Accessibility of fuel valves.
7) Vulnerability of fuel tank to damage or exposure to electrical shock.
8) Ease and permanence of component alignment.

e. For the generator:

1) Ease of generator removal and installation.
2) Ease of removal and installation of engine-generator coupling devices.
3) Ease of brush removal and installation.
4) Ease of generator-engine alignment.

f. For the electrical accessories:

1) Ease of component removal and installation
2) Lack of terminal strips where deemed necessary
3) Presence of solder rather than screw terminals on element leads
4) Ease of adjusting regulating devices
5) Ease and permanence of aligning indicators

6.3.1.2 Inventory Check

List any materials missing from the Basic Issue Item List (BIIL)

6.3.1.3 Physical Characteristics

Record the data required by MTP 10-2-500

6.3.1.4 Operator Training and Familiarization

Record the data required by MTP 10-2-501.

6.3.1.5 Pre-operational Checks

Record the following:

a. Depreservation procedures utilized.
b. Any assembly, cleaning or component tightening required.
c. Any controls or adjustments which are locked or do not fuction smoothly.
d. Adjustment mechanisms which do not operate, are not smooth, or which cannot be locked.
e. Lubrication procedures, material, and equipment utilized or defective lubrication points on the test item.

6.3.2 Test Conduct

6.3.2.1 Operational Performance

NOTE: Whenever a test result is dependent upon power generator load, be sure to record power factor of load. (This value will be 1.0 for dc generators and normally 0.8 for ac generators).

6.3.2.1.1 Preliminary Electrical Tests -

Record the following:

a. Improperly wired power output leads
b. Insulation resistance in megohms for each circuit
c. Identification of circuits that fail dielectric strength test
d. Armature - field air gap measurements

6.3.2.1.2 Speed and Voltage Regulation -

Record the following for each voltage and frequency connection:

a. Data collected as described in the applicable sections of MIL-STD-705A, Method 614.1.
b. Any roughness, hesitancy, or other erratic engine performance.

6.3.2.1.3 Stability and Transient Response -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 608.1.

6.3.2.1.4 Harmonic Analysis -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 601.4.

6.3.2.1.5 Ripple Voltage -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 650.1.

6.3.2.1.6 Vibration Test -

a. Record data collected as described in the applicable sections of MIL-STD-705A, Method 740.1a.
b. Record maintenance data collected as described in paragraph 6.2.6.

6.3.2.1.7 Dynamic Balance -

Record the following for each generator speed and load:

a. Speed in rpm
b. Load
c. Location of vibration instrument
d. Vibration amplitude, in inches
e. Evidence of abnormal operation

6.3.2.1.8 Generator Efficiency -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 415.0.

6.3.2.1.9 Phase Balance (voltage) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 508.1b.

6.3.2.1.10 Phase Balance (current) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 508.2.

6.3.2.1.11 Circulating Current -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 509.1.

6.3.2.1.12 Rheostat Range -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 510.1b.

6.3.2.1.13 Regulator Range -

Record data collected as described in the applicable section of MIL-STD-705A, Method 511.1b.

6.3.2.1.14 Frequency Adjustment Range Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 511.2a.

6.3.2.1.15 Overspeed

Record data collected as described in the applicable sections of MIL-STD-705A, Method 505.1.

6.3.2.1.16 Overspeed Protection Devices -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 505.2.

6.3.2.1.17 Underspeed Protection Devices -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 506.1.

6.3.2.1.18 Under Frequency Protection Devices -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 514.1.

6.3.2.1.19 Voltage Unbalance with Unbalanced Load (Line-to-Neutral Load) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 620.1.

6.3.2.1.20 Voltage Unbalance with Unbalanced Load (Line-to-Neutral Load) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 620.2

6.3.2.1.21 Voltage Unbalance (Three-wire, Single-phase) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 620.4.

6.3.2.1.22 Voltage-Frequency Control -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 511.3a.

6.3.2.1.23 Short-Circuit Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 625.1b.

6.3.2.1.24 Circuit Interrupt Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 512.2b.

6.3.2.1.25 Reverse Current Relay Test (28 vdc generators) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 512.4b.

6.3.2.1.26 Instrument Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 513.1b.

6.3.2.1.27 Judging Commutation (AC Generators) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 651.1b.

6.3.2.1.28 Judging Commutation (DC Generators) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 651.26.

6.3.2.1.29 Inclined Operation -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 660.1b.

6.3.2.1.30 Maximum Power -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 640.1b.

6.3.2.1.31 Parallel Operation -

Record data collected as described in the applicable sections of MIL-

STD-705A, Method 630.1b.

6.3.2.1.32 Low Oil Protection Device Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 515.1.

6.3.2.1.33 High-Water Temperature Protective Device Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 515.2.

6.3.2.1.34 High Temperature Protective Device Test -

Record the following for each thermocouple installed on the engine:

a. Location of thermocouple
b. Temperature at thermocouple at which protective device operates

6.3.2.1.35 Low Coolant Protective Device Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 515.3a.

6.3.2.1.36 Shaft Current -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 652.1.

6.3.2.1.37 Start and Stop Test -

Record data collected as described in the applicable section of MIL-STD-705A, Method 503.1a.

6.3.2.1.38 Unbalanced Load Heating Test -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 621.1.

6.3.2.1.39 Heat Run -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 680.1a.

6.3.2.1.40 Starting and Operating Test, Low Temperature, -65°F. (-54°C.) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 701.1b.

6.3.2.1.41 Standby Operation Test, Low Temperature, -65°F. (-54°C) -

Record data collected as described in the applicable sections of MIL-STD-705A, Method 702.1a.

6.3.2.2 Environmental Tests

Record data collected as described in the applicable sections of the following test methods of MIL-STD-705A:

a. High temperature test, Method 710.1b
b. Humidity test, Method 711.1b
c. Fungus resistance test, Method 711.2
d. Sand and dust test, Method 711.4
e. Salt fog test, Method 711.5
f. Immersion test, Method 711.6
g. Altitude operation test, Method 720.1b
h. Storage test, extreme cold, -80°F (-62°C), Method 731.1a
i. Storage test, extreme heat, +160°F (+71°C), Method 732.1a

6.3.2.3 Electromagnetic Interference

a. Record for each test and its frequency band, the frequency and its corresponding highest in-band interference reading and out of tolerance values.

b. Retain diagram of the test set-up.

6.3.2.4 Durability

Record the following:

a. Data collected as described in the applicable sections of MIL-STD-705A, Method 690.1b.

b. For the inspection data:

1) Time of inspection
2) Evidence of wear

6.3.2.5 Transportability

Record data collected as described in the applicable sections of MTP 10-2-503.

6.3.2.6 Maintenance

Record data collected as described in the applicable sections of MTP 10-2-507 and MTP 10-2-512.

6.3.2.7 Safety

Record the data collected as described in the applicable sections of MTP 10-2-508 and the following:

a. For each safety device/feature:

1) Name of device/feature
2) The type of failure each device is to detect
3) Indication that the device has operated successfully

b. List any missing devices or unsafe conditions
c. List any suggested additions to the test item's safety features

6.3.2.8 Human Factors Evaluation

a. Record data collected as described in the applicable sections of MTP 10-2-505.
b. Record the following for each measuring location:

1) Location of measurement
2) Highest noise level in each band
3) Ambient noise level

c. Retain diagram of the test set up
d. Retain completed check lists

6.3.2.9 Value Analysis

Record the following:

a. The component or feature involved
b. Suggested change
c. Reasons for the suggested change

6.3.2.10 Quality Assurance

Record data collected as described in the applicable sections of MTP 10-2-511.

6.4 DATA REDUCATION AND PRESENTATION

6.4.1 Operational Performance

Perform calculations as indicated in the applicable sections of MIL-STD-705A. Present the results of the tests in tabular, narrative or other suitable form, supplemented by photographs and graphic or art presentations as required.

6.4.2 Environmental Tests

a. Use drawings, photographs and narration to describe any evidence of physical deterioration of the power generator resulting from these tests.
b. Compare the data tabulated in paragraph 6.4.1 before and after the test were applied.
c. Prepare a chart to show any significant variations of data.

6.4.3 Electromagnetic Interference

Prepare a table showing the interference test conducted, out of limit readings, or the highest reading in the band and corresponding frequency. Consult the graphs of MIL-STD-461 for maximum allowable readings.

6.4.4 Durability

a. Analyze all abrupt changes in test item indicators for a possible malfunction.

b. Compare the data with data obtained and processed during the operational performance tests.

c. List any indications of accelerated wear of the test item.

d. Present the results of the durability test in the form indicated in MTP 10-2-502.

6.4.5 Human Factors Evaluation

Prepare a table showing measurement locations, the highest noise readings in each band and the ambient noise. Include a column for corrected noise readings with the new readings to be determined in the following manner:

a. If the difference between the noise reading and the ambient reading is 3 decibels or less, mark corrected reading "indeterminate".

b. If the difference is between 4 and 10 decibels consult Table II.

TABLE II. CORRECTIONS FOR AMBIENT SOUND PRESSURE LEVELS

Difference in decibels between sound pressure level measured with sound source operating and ambient sound pressure level alone.	4	5	6	7	8	9	10
Correction, in decibels, to be subtracted from sound pressure level measured with sound source operating to obtain sound pressure level due to sound source alone.	2.2	1.7	1.3	1.0	0.8	0.6	0.4

c. If the difference is greater than 10 decibels, no corrections necessary.

d. Circle those readings which are out of limit by consulting Table I which contains the allowable limits as given by HEL Standard S-1-63B, Maximum Noise Level for Army Materiel Command Equipment.

6.4.6 General

Tabulate and summarize the remaining data as appropriate. All data shall be compared with the technical performance characteristics specified in the QMR's, SDR's, or other specifications.

At the completion of the test, issue a Safety Release Recommendation in accordance with USATECOM Regulation 385-6.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) US Army Test and Evaluation Command (USATECOM) Aberdeen Proving Ground, Maryland 21005	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP ----------

3. REPORT TITLE

US Army Test and Evaluation Command Materiel Test Procedure 9-2-286, Commodity Engineering Test Procedure, - "Power Generators."

4. DESCRIPTIVE NOTES (Type of report and, inclusive dates)

Final

5. AUTHOR(S) (First name, middle initial, last name)

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6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO OF REFS
25 March 1970	32	28

8a. CONTRACT OR GRANT NO. DA-18-001-AMC-1045(R) b. PROJECT NO AMCR 310-6 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) MTP 9-2-286 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) ----------

10. DISTRIBUTION STATEMENT

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11. SUPPLEMENTARY NOTES ----------	12. SPONSORING MILITARY ACTIVITY Headquarters US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005

13. ABSTRACT

This Engineering Test Procedure describes test methods and techniques for evaluating the technical performance and characteristics of Portable Power Generators (AC or DC Types), and for determining their suitability to undergo service test. The evaluation is related to criteria expressed in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other applicable design requirements and specifications.

DD FORM 1 NOV 65 1473 (PAGE 1)
S/N 0101-807-6811

UNCLASSIFIED
Security Classification

A-31408

UNCLASSIFIED
Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Engineering Test						
Portable Power Generator (AC or DC Types)						
Test Procedures						
Test Methods and Techniques						

DD FORM 1 NOV 65 1473 (BACK)
(PAGE 2)
S/N 0101-807-6821

UNCLASSIFIED
Security Classification

A-31409